A group of experts from the Electromagnetic Radiation Management Advisory Council (ERMAC) assessed the radiation bombarding the Moscow Embassy, and the biological trauma reported by DOS personnel. Their consensus was the same as that of the APL and Lilienfeld teams.

ERMAC Analysis

In 1980 the ERMAC met to assess the biological implications of the microwave environment in Moscow. Members of the group included experts from universities, hospitals, and private companies. The consultants were employed by General Electric, the University of Washington, the Virginia Commonwealth University, NTIA, APL, George Washington University, the University of California, Bell Laboratories, Gerry L Pettis Memorial Veterans Hospital, Argonne National Laboratories, and the universities of Miami and Tulsa; one consultant was an independent engineer. The ERMAC experts concluded:

> The models used for the analysis of biological hazards are overstated. Other electromagnetic radiation is more intense than that impinging on the Embassy. There is no scientific evidence, or theoretical grounds, to suggest that biological disorders reported by Embassy personnel were due to microwave irradiation.

And so the effects of microwave radiation in Moscow ended on the same note as VDT studies: There is no evidence that low level nonionizing radiation causes tissue damage; biological perturbance is due to chance. It appears that neither the APL, Lilienfeld, nor ERMAC endeavored to find a common factor. So it is in the VDT environment, and investigations of alleged injury from the emissions of high voltage power lines.

BIOLOGICAL INTERFERENCE

The potential of the biosystem changes when organisms absorb excessive natural or artificial electricity. Galvani and other scientists discovered that electric current causes friction as it travels through tissues and associated chemicals. Spasms in the nerves and muscles, and chemical change are the visible reactions to energy absorption. An elevated biological charge is the invisible effect. However it is perceptually apparent

in that individuals or organisms gain weight, become hyperactive, and dart about like ignited firecrackers.

Charged tissues vibrate at high frequencies. Ions rushing through them to ground create a sort of "ionic wind" (conduction current). The added energy causes chill inside and outside the body. VDT users experience these sensations which were observed in other organisms. Workers use heaters to ward off chill. Heat causes fast chemical reactions that exacerbate their perturbance. Bridges and Preache analyzed data that showed change in organisms exposed to electromagnetic radiation.

Power Line Radiation

In 1979 Jack E Bridges and Maurline Preache reviewed literature on the biological effects of electric fields from high voltage power lines; excerpts follow.

> Electric fields induce the same current in the body as household appliances. Therefore the electric field of power lines is only a subset of the usual 50 and 60 Hz electromagnetic environment of industrialized communities.

Depending on the distance it must travel and other factors, a power line carries 10,000 to over 500,000 volts. Its energy is stepped down to 120 or 220 volts, which vibrates at a frequency of 50 or 60 Hz. If 120 volts can electrocute humans, 10,000 volts dissipating from power lines must have some biological effect.

> Most investigators used fish and other organisms as test subjects. The reactions of animals cannot be compared to those of humans. For that reason, it is not yet understood how electric and magnetic fields induce currents and electrical potentials in humans and animals. (Energy flows in humans as it does in any electrical and electronic circuit.)
>
> The electromagnetic fields of power lines produce small arc discharges, air ions, low level acoustics, and radio noise. These phenomena are confined to the immediate area within 100 feet of power lines. The electromagnetic fields charge the skin, causing electric current to flow within humans, and through the body to ground.

3. US Embassy (Moscow)
Hazard at: **1μW/cm2**
Result: Illness and death

ASSESSMENT OF HEALTH HAZARD AND STANDARD PROMULGATION IN CHINA

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Hangchow, China

In general, radiofrequency and microwave radiation at sufficient levels of intensity and duration of exposure could cause harmful effects on a living organism, but the bioeffects and their mechanism are not yet well known. There are many uncertainties and differences of opinions, so that the safe exposure limits proposed in various countries differ from each other greatly, and there are two different types of safe exposure standards to consider depending on the population to be protected. There is an occupational standard which is used to protect persons working in the RF or MW environment, and an environmental standard to protect the general public. The safe exposure level of the latter is often as low as one tenth of the former, because the general population includes children, pregnant women, and individuals with various diseases. Both of these exposure standards differ from the emission or performance standards which restrict the emission of radiation from devices, such as the emission standards for microwave ovens in the United States and Canada. An exposure standard refers to the maximum permissible exposure level to the body, which must be based mainly on realistic assessment of health hazard, and which is to be discussed here.

Setting of the standards is not a simple task. It is necessary to establish a quantitative relationship between power densities of incident radiation and all biological effects for human beings. Quantification of the biological response to microwaves is a complex problem because of the wide range of the frequency spectrum. There are a large number of physical and biological variables and complex interrelationships among these variables. Most of the scientific data has been obtained from experiments on small animals or simpler organisms, and extrap-

olating laboratory results to man is not a clearly defined process. Additionally, there is a large amount of uncorroborated and controversial evidence of various biological effects. In these cases, the assessment of health hazard for "Standard" promulgation should rely mainly on the health status of personnel professionally exposed to RF and MW, although the information available in this field is limited. In various radiation conditions of human exposure, since it is impossible to make quantitation precisely and distinction between various radiation conditions strictly, the results of experiments with animals on bioeffects of RF and MW should be supplemented to the human exposure data.

Assessment of Health Status of RF and MW Workers

Some cases of acute reaction to microwave overexposure have been encountered [1]. The syndrome seems to consist mainly of subjective complaints of headaches, nausea, vertigo, and sleeplessness. Objectively, hypertonia, changes in cardiac rhythm, and a skin rash may be encountered. EEG examination may show a decrease in amplitude of alpha waves. In all cases the symptoms were transient and disappeared completely after a few days of sedation and rest. In one case, noted by the present author, the patient was extremely excited, highly unsteady in body temperature and heart rate, and evidenced reversible impairment of visual acuity and ventricular block. The symptoms lasted several weeks, even months. In general, the power density of microwave exposure causing acute reaction must be above at least 30 mW/cm^2. There is no doubt that the maximum permissible exposure level should be far below that level.

In setting a standard, one of the most important considerations has to be chronic exposure. As the assessment of the relationship between exposure levels and the health status of personnel professionally exposed to RF and MW is difficult, large groups must be observed in order to obtain epidemiological data with statistical significance. Many contributions in this field have been made by Soviet authors. Papers have also been published by authors from Czechoslovakia, Poland, USA, Sweden and so forth. In recent years, some investigations have been carried out in China. A large part of these findings concerning health hazard will be discussed here jointly.

The first topic is quantitation of human exposure. In view of the lack of personal dosimeters, the quantitation of exposure during work is extremely difficult, particularly where the personnel move around in the course of their duties and are exposed to moving beams or antenna of radars. Additionally, it is impossible to evaluate the exposure over a period of several years. So on the basis of analysis of working conditions, authors usually roughly divide the

personnel examined into two or three groups named high, (middle), and low power density groups. In fact, the exposure levels generally range from some tens to several hundred uW/cm^2 for professional microwave workers. One or two hundred uW/cm^2 as the demarcation line between high and low power densities has been adopted by some researchers. Only in a few working places do the microwave exposure levels exceed 1 mW/cm^2 or 10 mW/cm^2.

The principal part of the clinical findings from observed microwave workers is similar in different countries. Symptoms of functional disturbance in the central and vegetative nervous systems are the main manifestation. These will be described in the following with the results of investigations in China being compared with those in other countries. The investigation [2] on which the "Chinese Tentative Standard" is mainly based was conducted in 11 factories and institutes. The microwave workers observed had worked with microwave equipment (most of them were PW in cm range) more than one year, and a large part of them had 5 - 15 years of working experience. Everyone in the study had been in an ordinary work setting for the last three months. There were 841 workers given clinical observation, with 471 persons observed as a control group, their sex and age distribution similar to that of the microwave workers. The microwave workers were divided into two groups in terms of power density exposed. The first group, 306 workers, was exposed to a higher power density of >200 uW/cm^2 and the second group of 535 workers, to a lower <200 uW/cm^2. There was no significant difference in ages and working experience of these two groups ($p<0.05$).

1. Effects on the Nervous System

The results confirm the previous findings of Soviet authors on the occurrence of subjective complaints (Table 1). Another finding in the microwave workers was the partial loss of hair. The most pronounced symptoms were headache, fatigue, disturbance of sleep (insomnia or somnolence) and decrease in memory. The persons who complained of any of the three symptoms mentioned above were defined as "neurasthenia" and the incidence of neurasthenia is shown in Table 2. It is indicated that there were significant differences between any two groups.

A part of the observed persons (106 in all) were examined for EEG. The microwave workers' EEG revealed an increase in theta and delta waves, but there were no significant differences in statistics.

Similar complaints and incidences of neurasthenia symptoms were observed in RF workers in China, and the places where they worked were at the field strengths of several hundred V/m.

TABLE 1 Complaints of Microwave Workers (%)

Authors	No. of workers	Headache	Fatigue	Sleep disturbances		Memory decrease	Irritability	Hyperhidrosis	Abnormal menstruation
				Sleepless	Sleepiness				
Present authors (1979)	841	44-44.8	38-40.5	25.5-26	11-11.1	46.4-50	14.4-19	12.1-18	14.6-20
Sadcikova (1974)	1180	44-45	47-57		11-14	10-22	28-38	32-58	
Ramzen-Evaokinov (1970)	155	44	29	35			36	25	
Tjagin (1966)	573	33.5	46.2	25.3			9.6	25.5	
Uspenskaja (1963)	100	37	31	29			9	7	
CONTROL									
Present Authors	471	27.6	14.4	18.3	4.3	17.2	9.6	6.6	6.6
Sadcikova	200	12	7		2	1	6	12	
Ramzen-Evdokinov	50	7	8	3				4	
Tjagin	184	10.8	5.9	8.7				2.7	
Uspenskaja	100	15	22	2				4	

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TABLE 2: Incidence of Neurasthenia Symptoms

Group	Incidence (%)	Groups for X^2	p
1	32	among all	<0.001
2	24.1	high to lower	<0.02
3	11	lower to control	<0.001

2. Effects on the Cardiovascular System

The microwave workers who complained chiefly of palpitation and pains around the cardiac region were in the high power density microwave radiation group; the incidences were much higher than for the control group ($p<0.001$). The incidences of hypotonia ($\leq$100 mm Hg) were higher in the microwave groups (high and lower density group in 25.5% and 22.6% respectively) than in the control group (15.3%). Reviewing the reports [3,4,5] published by Soviet authors, we could find that the incidence of hypotonia in RF and MW workers mostly is 20-40%, and in the most recent ten years, the incidence of hypertonia is higher than hypotonia. It has been suggested that hypertonia increases with working age, and occurs in advanced stages of the disease. Glotova observed the dynamic alteration of blood pressure of microwave workers. She divided the observed persons into three groups according to their initial pressure. They all were near thirty years of age.

TABLE 3: Dynamic Alteration of BP in MW Workers

Group No.	Observed Time	Total	BP (mm Hg) 90-95	100	105-135	140-145	150-160
1	initial	17	8	9	0	0	0
	after 3-6 years		3	6	2	3	3
2	initial	17	0	0	17	0	0
	after 3-6 years		0	0	5	6	6
3	initial	9	0	0	0	8	1
	after 3-6 years		0	0	0	1	8

The microwave exposure effects on ECG showed changes in cardiac rate, minor downward displacement of the S-T segment, lowering of T deflection, and slight deviations from normal in excitability and conduction of cardiac-electric activity (Table 4).

TABLE 4: Changes in ECG (Incidence %)

Group No.	Deep Bradycardia 50/min	Tachycardia 100/min	ST-T male	ST-T female	lower P 0.1s	QRS 0.1s	High potential at left ventricle (male)
1	1.63	6.54	11.8	34.29	6.86	10.78	11.92
2	3.93	3.36	11.2	14.61	7.85	11.59	12.89
3	0.42	4.25	5.6	18.07	3.18	4.03	8.95

In order to observe the microwave exposure effects on vascular functional state, rheoencepalogram, rheogram of finger hemodynamics and oculi fundus were examined. There were no significant findings in the results.

The data mentioned above show that microwave action was characterized by autonomic vascular symptoms of a vagotonic character, expressed especially in hypotonia and bradycardia. Sadchikova and many Soviet authors [4,5,6] state that the asthenic syndrome in the initial stages included mainly a complex of asthenic symptoms dominated by autonomic vascular changes with a vagotonic tendency. In the advanced stages of the disease, the astheno-autonomic syndrome with vascular dysfunction of the hypertonic type was most frequent. At a certain stage of development of autonomic vascular disturbances, the hypothalamic syndrome (autonomic vascular form) appeared and was characterized by sudden crises, predominantly of a sympathico-adrenal character. In our investigations, the autonomic vascular symptoms of most persons maintained a vagotonic character, while they were observed over a period of five years. Nothing of such severity as to be described as hypothalamic syndrome was found. It seems that the nature and sensitivity of cardiovascular reactions to prolonged exposure depend, to a large extent, on the individual characteristics. Further study on clinical manifestations and its mechanism could be valuable, as some doctors in our country are now interested in using microwave in treatment for hypertension.

The hypotonia and bradycardia were also observed in RF workers in China, but the incidence was not so high as that in microwave workers.

3. Effects on peripheral blood

No characteristic changes in peripheral blood picture were found, only a slight leukopenia and thrombocytopenia occurring in the first group as compared to the others ($p<0.001$).

Table 5 Incidence of Leukopenia and Thrombocytopenia

Group No.	Leukocyte (%) <5,000/mm^3	Leukocyte (%) >9,000/mm^3	Thrombocyte (%) <100,000
1	29.41	1.96	26.79
2	18.69	8.6	14.02
3	21.23	7.2	17.2

Diversified WBC responses are found in many reports. In general, slight or moderate leukopenia may be found in microwave workers working at high power densities. In a number of cases leukocytosis was encountered in the initial period of professional exposure. Absolute lymphocytosis may also be found in microwave workers.

4. Effects on eye

Several epidemiological surveys of lenticular effects of microwave workers have been performed. None of the surveys reported a statistically significant increase in the number of cataracts in personnel occupationally exposed to microwave radiation. The surveys were mostly concerned with minor lenticular defects. Some of the surveys indicated a statistically significant increase in lenticular defects in microwave workers. Zydecki [7] examined 3,000 persons divided equally into three groups. Group A comprised two subgroups. A_1 contained 542 individuals exposed directly to microwave radiation at power density of about 0.1 mW/cm^2 up to 6 mW/cm^2. Group A_2 comprised 458 individuals exposed to MW at about 0.01 mW/cm^2. Group B comprised 1,000 age-matched individuals not exposed to microwave, while Group C was made up of children and juveniles aged 5 to 17 years. The examination of the lens was made using a slit lamp after dilatation of the pupil. Lens translucency was assessed using a 5-grade scale:

1° No lens changes
2° Numerous small, multishaped opacities, which may be counted
3° Numerous small, multishaped opacities, which are difficult to count
4° As above, but with a tendency to increase in number or size on successive examinations
5° Any change impairing visual acuity

Statistically significant differences in the frequency of various grades of lens translucency exist between Group A and Groups B and C. Moreover the comparison between A_1 and A_2 also demonstrates significant differences (Table 6). The author indicated that long-term overexposure to low doses of microwaves may tend to accelerate the normal aging process of the lens.

Table 6 Percentage incidence in various lens translucency grades

Lens Tranclucency Grade	Group A A_1	A_2	A_1+A_2	Group B	Group C
1	13.0	31.3	21.7	29.7	68.8
2	62.0	52.6	57.7	50.3	26.9
3	19.7	12.2	16.2	16.6	3.6
4	4.8	3.5	4.1	2.6	0.3
5	0.5	-	0.3	0.8	0.4

In our investigation, the lenticular transparency was examined in 227 microwave workers and 117 age-matched persons as control. No significant differences in incidence of lens opacities were found. The incidence of lens vacuole in the first group was higher than that in the control group ($p<0.025$). A few cases of cataracts or retina hemorrhage points were found in the microwave workers.

Table 7 Incidences of lens changes (%)

Group No.	Lens opacity	Lens vacuole
1	71.21	24.24
2	76.4	15.53
3	79.4	10.26

Tengroth and Aurell [8] reported an increased number of retinal lesions in 68 workers in a Swedish factory where microwave equipment was tested. The retinal lesions were characterized by their resemblance to chorioretinal scars after inflammatory reactions. No data on the intensity of the radiation were provided, but the authors considered that the maximum permissible exposure of 10 mW/cm^2 is too high. The problem should be further investigated.

5. Reproduction and Genetic Effects

Microwave radiation can induce sterility in humans when the incident power density is high enough. In recent years, microwave has been used for birth control in some hospitals in our country. In some workers occupationally exposed to RF or MW, the spermatogenesis or menstrual pattern was altered, and even impotence occurred. But the total number of cases are too few to conclude a cause/effect relationship.

RF and MW radiation are teratogenic to experimental animals exposed at specific times during gestation, but there is no evidence of such in humans. The use of microwave heating as diathermy to relieve the pain of uterine contractions during labor was reported from Belgium. It was said that the babies were born healthy. Nevertheless, extreme caution must be exercised. A few cases of multiple inborn defects in the offspring of women irradiated

immediately before or during the early stages of pregnancy with shortwave diathermy have been reported by Coccorza Erdman et al.

Siglor et al suggest that mongolism occurs more frequently among the offspring of fathers professionally exposed to microwaves. However, an intensive follow-up study failed to confirm the association. In general, there seems to be no hazard under ordinary professional exposure conditions.

In the United States, a study [9] of American Embassy personnel in Moscow was reported. The purpose of the study was to compare the morbidity and mortality experience of U.S. Government employees at the Moscow Embassy during the period 1953 to 1976 with the experience of employees who had served in other selected, nonirradiated Eastern European embassies during the same period. The study population consisted of 1827 employees at the Moscow Embassy and over 3000 of their dependents and 2561 employees at the eight comparison posts and 5000 of their dependents. Comparative analyses were made of all symptoms, conditions, diseases, and causes of death according to the abstract of the medical records, response to the Health History Questionnaire, diseases reported on the Questionnaire, and acquisition of death certificates. No differential health risks associated with presumed exposure to microwave radiation were demonstrated. The maximum exposure levels measured at or near the windows of the upper central building ranged from 1 uW/cm^2 to 15 uW/cm^2. Another study [9] was reported of a three year investigation that was aimed at the determination of health risks from microwave radiation of U.S. Naval persons. A population of approximately 40,000 (half constituted the exposed group, and half the control group) were examined for mortality, morbidity, reproductive performance and health of children. The data did not show any differences between the two groups. It did not assign the exposure doses to any individuals in this study. Some of the observed persons were exposed to microwave in excess of the 10 mW/cm^2 limit. Accidental exposure was at estimated levels exceeding 100 mW/cm^2. Radiomen and radar operators were generally exposed to levels well below 1 mW/cm^2.

It may be summarized that there are great differences in the methods, contents and results of investigations for evaluating the health hazard of microwave radiation between different countries, causing great controversy. Additionally, the health hazard in microwave usually is not so serious and so certain as that in any other disease. Numerous questions concerning the clinical course and pathogenesis of certain lesions caused by RF and MW radiation have not been clearly elucidated up till now, and the symptoms usually are reversible, but the existence of health hazardous effects of RF and MW can not be denied. An investigation [6] of the patients suffering from microwave sickness reported by Sadechikova illustrates this. It showed that, despite repeated therapeutic

courses and temporary withdrawal from work with microwave sources, upon returning to previous work conditions symptoms increased in severity, particularly among patients with advanced stages of the disease. In such patients autonomic vascular disturbances dominated, crises of cerebral and coronary insufficiency progressed and development of ischaemic heart disease and hypertension was observed. Cessation of work involving irradiation frequently resulted in stabilization of the initial stage of illness (Table 8).

Table 8 Clinical course of microwave radiation during and after exposure

Clinical syndromes	Period of observation	No. of cases	Clinical course		
			Recovery	Stabilization	Progression
Asthenic	A	25	-	13	11
	B	5	3	2	-
Astheno-autonomic with vascular dysfunction	A	47	-	-	47
	B	16	-	15	1
Hypothalamic (autonomic vascular form)	A	2	-	-	2
	B	6	-	5	1
Total		100	3	35	62

A: under MW exposure B: after cessation of exposure

This implies that those syndromes are not easy to recover, and it is important to lower exposure level and improve work conditions for protection from hazardous radiation.

Radiation conditions related to health hazard and standard promulgation in China

In order to set a reasonable safety standard of RF and MW radiation, conditions related to health hazard should be reviewed. Several exposure standards [10,11,12,13,14] in different countries are reported.

1. Radiation intensity

It might be considered that according to epidemiological data from exposure to microwave energy, long-term exposure at several mW/cm^2 may induce alteration not only in nervous and cardiovascular systems, but in the normal aging process of the lens and peripheral

blood picture. The function of the nervous and cardiovascular systems might be influenced at about one or two hundred uW/cm^2. Considering that the lower power density group (<200 uW/cm^2) in our investigation mentioned above had more alteration in blood pressure and ECG, we selected 238 persons who had been exposed to microwave power density less that 50 uW/cm^2 and their age- and sex-matched individuals as control. There were still significant differences in the incidence of neurasthenia symptoms. However, there was no difference in objective indexes between the two groups in statistics. Although some reports stated that the microwave exposure group at a few hundredths of a mW/cm^2 had similar functional changes in the nervous and cardiovascular systems, it seems that there is no correlation between the exposure intensity and the changes. Gordon and other authors indicated that in low level exposure groups similar effects were observed, but symptoms were less evident and easily reversed. This impression is strengthened by the fact that after reducing the exposure levels, no further cases with pronounced dysfunction syndrome were noted.

In order to search for the threshold level of microwave bioeffects on animals, acute and chronic experiments were conducted.

Acute effects of microwave radiation on blood pressure, respiration, rectal temperature, subcutaneous temperature and ECG were observed [15]. In this experiment using rabbits, the whole body was radiated on its abdominal side with 2450 MHz continual microwave for 1 hr. There were five groups with 68 rabbits in all divided into 80 mW/cm^2, 40 mW/cm^2, 20 mW/cm^2, 10 mW/cm^2 and control. The microwave radiation induced a drop in blood pressure, acceleration of respiration, and elevation of subcutaneous and rectal temperature (Table 9).

Table 9 Variation on acute experiment

Investigated items	80 mW/cm^2	40 mW/cm^2	20 mW/cm^2	10 mW/cm^2	Control
Blood pressure drop mean (mm Hg)	25	18	22	-	-
Respiratory rate increase mean (per min.)	109	55	-	-	-
Subcutaneous tem. pure rise mean (^oC)	5	3.1	1.6	-	-
Rectal tem. pure rise mean (^oC)	2	1.3	0.3	-	-

- no significant changes

The chronic experiment was conducted with 16 rabbits and 40 rats. The rabbits were divided into four groups at random from which three groups were irradiated with three levels (10, 1, and 0.1 mW/cm^2) and one served as control. The rats were divided into four groups, from which three groups were irradiated with the other three levels (5 mW/cm^2, 0.2 mW/cm^2 and 0.01 mW/cm^2) and one was control. The exposed groups were irradiated six hours daily for four and a half months. A certain power density of microwave (300 mW/cm^2) induced EEG frequency slowing and amplitude increasing. The most pronounced changes of ECG were bradycardia, tachycardia and R wave widening. Leukocyte and leukocytic alkali phosphatase increased in the first half a month and then there were no changes. Blood presure fluctuated. Mistakes at Y-labyrinth test appeared to tend to increase. The relationship between these variations and power densities is shown in Table 10.

Table 10 Relation between the variance of observed indexes and power densities

Items	10 mW/cm^2	5 mW/cm^2	1 mW/cm^2	0.2 mW/cm^2	0.1 mW/cm^2	0.01 mW/cm^2	control
EEG							
amplitude	++	/	-	/	-	/	-
frequency	++	/	++	/	-	/	-
ECG							
heart rate	/	++	/	-	/	-	-
R widen	/	++	/	++	/	-	-
Leukocyte	/	++	/	-	/	-	-
L A P	/	+	/	-	/	-	-
Blood pressure waved	++	/	-	/	/	-	-
Rectal tem.	-	-	-	-	-	-	-
Body weight	/	+	/	-	/	-	-

++ represents the variance with significant difference
+ represents the variance only with a tendency change
/ represents no animal exposed at this power density level
- shows no significant changes

The experimental data are preliminary and limited. A large number of experiments have been carried out in other countries.

The threshold of biological effects, which differs from health hazards, is extremely low. The average heart rate decreased during the pulsed microwave energy affected on frog hearts under certain conditions at only 0.003 mW/cm^2 average power density presented (Frey). The threshold of auditory responses for cats, the threshold of avoidance by rats of pulse modulated microwave, and the threshold of incidence efflux of calcium ions from the isolated chick or rat cerebral tissue (with frequency "window" modulated in amplitude) are far below or near 0.1 mW/cm^2. The threshold of hazardous effects in acute experiment is rather high and usually depends, to a great extent, on overheating.

The most important experiments, on which to base a set of safety standards, are long-term low level exposures. Dumenskij [16] reported an investigation performed at 10, 2.4, 1.9, 0.06, 0.01, and 0.006 uW/cm^2 for wavelength 6 m and 20, 10, 5 and 1 uW/cm^2 for 12 cm wavelength. The animals (rats and rabbits) were irradiated 8-12 hr. daily for 120 days. The experiment showed that in the conditioned reflex activity, the latent period was longer, reflex reactions to positive stimuli weakened, and the number of these missing increased. In this investigation these changes in the central nervous system were supplemented and confirmed by EEG, and biochemical studies including cholinesterase activity and sulphydryl (SH) groups in the blood. Changes in blood composition and morphologic structure of the tissues and organs of the animals were also observed. The author pointed out that prolonged action of electromagnetic energy of low intensities in the UHF and SHF ranges resulted in appreciable changes. The biologically active intensities of electromagnetic fields were 10-0.06 and 20-5 uW/cm^2 for UHF and SHF ranges respectively. Such low thresholds of hazardous effects of RF or MW radiation have not been supported by other reports. In some studies observed on the same systems and functions, negative results were obtained with even much higher power densities. However, a number of chronic experiments on bioeffects of RF and MW showing lower thresholds have been made by other Soviet authors.

In the United States, D'Andrea [17] reported a chronic experiment of exposure to 2450 MHz microwave. Long-Evans male rats were exposed 8 hr. a day for 16 weeks to microwaves at an average power density of 5 mW/cm^2. The dose rate was 1.23 mW/g. After exposure, it revealed a significant depression of behavioral activity. There were no effects on body mass, mass of adrenals, and levels of 17-ketosteroids in urine. Another long term experiment recently was presented by Guy and McRee [18,19]. Four rabbits were exposed to 2450 MHz microwave for 6 months. Daily duration of exposure was 23 hr. and continued across 180 consecutive days. The power density at the body axis of the animals was 7 mW/cm^2 and at the head location was 10 mW/cm^2. The average whole body SAR was 1.5 W/Kg. Eosinophil percentage, albumin and calcium levels were

significantly lower in exposed than in control rabbits. Thirty days after termination of exposure, no change in hematological parameters was observed, but a significant decrease in albumin/total globulin ratio was measured in the exposed animals. Lymphocytes from exposure animals showed a significant suppression in responsiveness to pokeweed mitogen. That microwave radiation may suppress immunological competence was reported by other studies. It seems that the power density of several mW/cm^2 may be critical to the effects observed on the immune system.

If we review the animal and human data on biological effects of MW and RF radiation, we find that there are considerable differences and controversy in this field. That the safety standard must be able to protect the health of the workers without obstructing the microwave techniques in extensive application. In accordance with our investigation and experiments, and referring to the experience of other countries, the power density at average 50 uW/cm^2 in the working place for a duration of six hours daily has been proposed as the tentative microwave occupational exposure standard in our country. If it is eight hours exposure a day, it must be less than 40 uW/cm^2. 300 uW/cm^2 is the limited dose for a whole working day. However, it is not permissible to be over 5 mW/cm^2. This tentative exposure standard has been adopted in local areas in our country for two years. It will be further perfected and decided by the end of this year.

2. Radiation frequency.

Because of the different reflection, propagation and absorption for different frequencies of electromagnetic field, the specific absorption rate must be different in a biological target from the same incident power density. Additionally, some special effects may occur at a certain frequency range. It is necessary to set separate standards for some frequency ranges.

Ermolajev and Subbota [20] suggested a formula to express the relation between the frequencies and electric field strengths, in which the equivalent bioeffects could be observed.

$$E_1 = E_2 \cdot \sqrt{\frac{f_2}{f_1}}$$

E_1 electric field strength in V/m for f_1 (MHz)
E_2 electric field strength in V/m for f_2 (MHz)

The formula was derived from the following data (Table 11).

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Table 11 Relation between frequencies and electric field strengths (V/m)

Bioeffects	Species	3 MHz	14 MHz	22 MHz	69.7 MHz	150 MHz	300 MHz
Functional alteration	rabbit	500 (615)	250 (285)	200 (220)	150 (125)	100-150 (90)	60 (60)
Death	mice	10000		3000			1000
	rat		5000		2000		

The properties of electromagnetic energy absorption and distribution under various frequency ranges were studied and manifested by many scientists (Schwan, Guy, Gandhi et al). In humans, maximum whole body SAR occurs in the frequency range of 60-100 MHz, with a peak at approximately 70 MHz. Human absorption at frequencies below 30 MHz and above 500 MHz is much less than that at the resonant frequency. Partial body resonant absorption occurs at 150 MHz for the arm and at 350 MHz for the head. In general, small animals absorb MW energy maximally at frequencies near or above 500 MHz. In view of this, the formula mentioned above is not fit for humans. It seems that the minimum intensity of maximum permissible exposure level should be at the frequency range of 30-300 MHz which is adopted in Canada's new standard. A new proposed exposure standard in America which is based on the whole body SAR equal to 0.4 W/kg is also the strictest at the resonant frequency range.

The lower limit of frequency regulated in the exposure standard is 10 MHz in some countries. The frequency range of electromagnetic field now widely used in industry of our country is from 0.25 MHz to 40 MHz and microwave. It seems that the frequency lowest limit of exposure standard should be at least at 0.2 MHz in RF range. Some cases of workers who suffered from typical neurasthenia resulting from RF radiation were found by the present author. A worker was exposed to 250 KHz near zone field at the electromagnetic field strength of about 400 V/m and 20 A/m over 5 years. Systolic blood pressure of this patient was highly unsteady with a 60 mm Hg fluctuation or so within a day. Bradycardia (ECG), slight leukopenia, emission and sterility occurred. Decrease in activity of sperms was found by laboratory examination. Slight abnormality in EEG appeared with more θ waves. After transient withdrawal from work with RF sources, the neurasthenia symptoms were observably relieved. After cessation of exposure to RF radiation over one year, the neurasthenia symptoms disappeared and disfunction of the cardiovascular system tended to recover. Similar, less extensive symptoms also occurred in a few other persons working at the same radiation condition. Another case is a woman who lived near a radio broadcast antenna with working frequency at 800 KHz. Keratoconjunctivitis resulting from lack of tear occurred while the patient was living there, and alleviated after she left there for

several weeks. This phenomenon happened several times. The electric field strength in her bedroom was about 20 V/m. Perhaps the patient was extremely sensitive to such an RF electromagnetic field. Perhaps disfunction of the endocrine system resulting from RF radiation was the main cause in reducing secretion of tears. Epidemiological data on RF radiation in China and some other countries also demonstrated that sufficiently intense RF radiation including the frequencies from 0.1 MHz to 10 MHz also can produce harmful effects. Several decades V/m will be adopted as the maximum permissible electric field strength for RF range in China.

3. Other radiation conditions

Several factors other than intensity, dose, and frequency range may also influence the harmful effects of RF and MW radiation. Pulsed and continual microwave may be different for their bioeffects. In Czechoslovakia, the exposure standards for them are different. In the new exposure standard of Canada, the maximum permissible level was differentiated between whole-body exposure and exposure of extremities. A distinction between continuous (stationary field) and intermittent (nonstationary field) exposure was made in Poland and then accepted by the Soviet Union in their microwave safety exposure standards. The ambient temperature and the presence of X-ray radiation are also considered in the USSR occupational exposure standard. All those factors should be investigated and studied further.

Finally it should be pointed out that the safety exposure standard will continue to be perfected with increasing knowledge.

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NEW YORK CITY MAKES A BAD CALL

Giuliani Administration To Build Cancer Alleys In New York

In a move that will create radiation alleys in New York City, the Giuliani Administration has announced that it is planning to grant communications companies the right to place transmission antennas on 3,000 lamp posts throughout the five boroughs.

It appears that no one has stopped to consider that such cellular phone and personal communication system transmission antennas emit potentially lethal electromagnetic radiation (EMR) that will bombard the city twenty-four hours a day, making the sidewalks and city streets literal radiation alleys.

In its scramble for approximately $3 million a year in rental income from such lamp posts, the Giuliani Administration is overlooking seventy years of research and hundreds of epidemiological, clinical and laboratory studies linking electromagnetic radiation to disease. These studies have confirmed over and over again that even extremely low-level exposure to microwave radiation adversely affects the heart and the nervous system, alters brain waves, damages the immune system, decreases fertility, and increases the rates of leukemia, brain cancer, miscarriage and birth defects.

According to a source at the Environmental Protection Agency (EPA), the radio frequency (RF) Safety Guidelines just released by the Federal Communications Commission (FCC) in connection with transmitting devices such as those proposed for use within the five boroughs, consider only the heating effect of high intensity microwaves, and do not address the health effects of chronic low-level exposure at all.

Unfortunately, it is our children that will be most affected by this radiation assault. The Victorian Division of the Australian Democrats has reported that **"Children absorb electromagnetic radiation at about three times the rate of adults. The smaller the child, the more radiation absorbed."**

In fact, David Carpenter, M.D., Dean of the School of Public Health, State University of New York at Albany has said **"I believe that 30% of all childhood cancers are associated with EMF exposure."** Others have advised that we should be cautious, rather than throwing caution to the wind when the health of our city's residents are at stake. Dr. Shirley Motzkin, Professor of Biology at Polytechnic University in Brooklyn has said **"There is conflicting evidence on the subject of adverse effects of EMR...Therefore cell phone companies should err on the side of caution and locate these stations away from residential areas."**

In a movement that mirrors a groundswell of international opposition to such cellular transmission facilities, the Cellular Phone Taskforce is alerting the New York community to the development of this dangerous situation. The Cellular Phone Taskforce has collected in excess of three hundred newspaper articles that have reported on citizen opposition to the placement of cellular facilities in the past two years alone. Numerous cities have passed laws banning or restricting cellular transmission antennas pending further research into this very serious issue. Dobbs Ferry, Greenburgh, Mamaroneck and Pound Ridge, New York are among them.

New York City residents have been concerned about this issue for quite some time. In fact, Community 4 has petitioned the Department of Buildings to remove a cellular phone station atop a building located at 350 West 51st Street. What the Giuliani Administration is proposing is 3,000 times worse than the single transmission facility at 350 West 51st Street, as it will create 3,000 light posts literally glowing with electromagnetic radiation. Residents, workers and tourists alike will not be able to escape the glowing posts.

Ralph Balzano, Commissioner of the Department of Information Technology and Telecommunications, has been alerted to the potential health hazards of the proposed transmission facilities by members of the Cellular Phone Taskforce, as have dozens of other New York City officials. In fact, Bioelectromagnetic Hygienist Marjorie Lundquist, Ph.D. has advised New York City health officials that the proposal to erect cellular phone transmission facilities atop lamp posts in New York will **"make New York City residents...unwitting guinea pigs in a city-wide bio-effects experiment!"**

The static over the proposed rental of the lamp posts has also come from a heretofore ignored sector of the New York community. Many New Yorkers have become electrically sensitive (ES) as a direct result of exposure to electromagnetic radiation from a variety of sources including powerlines, video display terminals, fluorescent lighting, household appliances and yes - cellular phone transmission facilities. Those New Yorkers suffering with ES have been forced to rearrange their lives in order to avoid all exposure to electromagnetic radiating devices. By mounting cellular transmission devices on lamp posts around the City, the Giuliani Administration will make the city virtually unlivable for these individuals. Indeed, locating such devices so close to human life will no doubt create thousands more ES victims.

The Cellular Phone Taskforce is calling upon the Giuliani Administration to consider the serious health ramifications of locating cellular transmitting devices close to human life. The Taskforce is asking the Administration not to approve the use of the public streets for this purpose.

Even if just one child contracts cancer because of this decision, will the $3 million gained be worth the suffering of that child and its family? Let's not allow one industry and the short term financial needs of the City of New York to take precedence over the health and well being of our entire city.

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